INCH-POUND

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(See 6.11)

MILITARY SPECIFICATION

PRESSURE TRANSDUCER EQUIPMENT (ELECTRICAL)

This specification is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers electrical output pressure transducer equipment for Naval ships but does not include the readout or display equipment.

1.2 Classification.

1.2.1 Type designation. The type designation shall be in the following form and as specified (see 6.2).

PGT	ST	100	G	4
Type (See 1.2.1.1)	Application (See 1.2.1.2)	Range (See 1.2.1.3)	Reference (See 1.2.1.4)	Power supply (See 1.2.1.5)

1.2.1.1 Type. Transducers shall be designated by the three-letter symbols as follows:

PGT - Pressure, gauge, transducer
PVT - Pressure, vacuum, transducer
PCT - Pressure, compound (gauge, vacuum) transducer
PWT - Pressure water column, transducer

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 6685

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1.2.1.2 Application. Fluid pressure to be measured shall be indicated as follows:

GP - Steam, oil, fresh water, condensate, and other gases
SW - Seawater
FG - Flue gas and ammonia
OX - Oxygen

1.2.1.3 Range. Full scale gauge pressure range in pounds per square inch (lb/in^2) inches of mercury (in Hg) vacuum or inches of water column (WC) shall be designated by its numerical value (see 3.4.3).

1.2.1.4 Reference. Reference pressure shall be one of the following:

G - Atmospheric (gauge)
A - Vacuum (absolute)
S - Sealed reference at 14.7 pounds per square inch absolute (lb/in^2 absolute).

1.2.1.5 Power supply. Wiring of the power supply shall be one of the following (see 3.4.5):

2 - Two-wire system (direct current (dc) supply)
4 - Four-wire system (alternating current (ac) supply)

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

PPP-F-320 - Fiberboard, Corrugated and Solid, Sheet Stock (Container Grade), and Cut Shapes.

MILITARY

MIL-S-901 - Shock Tests, H.I. (High Impact); Shipboard Machinery, Equipment and Systems, Requirements for.
MIL-E-917 - Electric Power Equipment, Basic Requirements for (Naval Shipboard Use).
MS3102 - Connectors, Electric, Receptacles, Box Mounting.
MS3106 - Connector, Plug, Electric, Straight, Solder Contacts, AN Type.

MILITARY (Continued)

MIL-C-5015 - Connectors, Electrical, Circular Threaded, AN Type, General Specification for.
MS16142 - Boss, Gasket Seal Straight Thread Tube Fittings, Standard Dimensions for.
MIL-E-17555 - Electronic and Electrical Equipment, Accessories, and Provisioned Items (Repair Parts): Packaging of.
MIL-L-19140 - Lumber and Plywood, Fire Retardant Treated.
MIL-S-19500 - Semiconductor Devices; General Specification for.
MIL-P-24423 - Propulsion and Auxiliary Control Consoles and Associated Control and Instrumentation Equipment, Naval Shipboard Use, Basic Design Requirements.
MIL-M-38510 - Microcircuits, General Specification for.
MIL-P-55110 - Printed Wiring Boards, General Specification for.

STANDARDS

MILITARY

MIL-STD-108 - Definitions of and Basic Requirements for Enclosures for Electric and Electronic Equipment.
MIL-STD-167-1 - Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II - Internally Excited).
MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.
MIL-STD-275 - Printed Wiring for Electronic Equipment.
MIL-STD-278 - Welding and Casting Standard.
MIL-STD-454 - Standard General Requirements for Electronic Equipment.
MIL-STD-461 - Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference.
MIL-STD-462 - Electromagnetic Interference Characteristics, Measurement of.
MIL-STD-701 - Lists of Standard Semiconductor Devices.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Document Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

DRAWINGS

MILITARY

NAVSHIPS 810-1385846 - Oxygen System, Submarine, Replenishment.

(Application for copies should be addressed to Commander, Portsmouth Naval Shipyard, Naval Engineering Drawing Support Activity, Code 202.2, Portsmouth, NH 03801.)

PUBLICATION

NAVSEA

NAVSHIPS 0900-LP-001-7000 - Fabrication and Inspection of Brazed Piping Systems.

(Application for copies should be addressed to the Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Non-Government publications. The following document forms a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

INSTRUMENT SOCIETY OF AMERICA (ISA)

Recommended Practice 37.1 - Nomenclature and Specification Terminology for Aerospace Test Transducers With Electrical Output.

(Application for copies should be addressed to the Instrument Society of America, P.O. Box 12277, Research Triangle Park, NC 27709.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated detail specifications, specification sheets or MS standards), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Qualification. Pressure transducers furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list at the time of award of contract (see 4.3 and 6.4).

3.2 Nomenclature. Nomenclature shall be consistent with the Instrument Society of America Recommended Practice 37.1.

3.3 Description. Transducer equipment shall be designed to convert a fluid pressure to a continuous linear proportional analog electrical dc signal. The pressure transducer shall consist of the following units:

(a) Detector to sense the fluid pressure.
(b) Power supply to provide excitation energy to the detector and signal conditioner.
(c) Signal conditioner to convert the detector output to a continuous linear proportional analog electrical signal.

3.3.1 Transducer may be supplied as separate units or may be packaged in any combination.

3.4 General requirements. Transducer equipment shall be in accordance with the requirements of MIL-P-24423 and as specified herein.

3.4.1 Materials. Transducer materials shall be in accordance with the prohibited and galvanic corrosion material requirements of MIL-E-917 and MIL-P-24423, and shall conform to requirement 4 of MIL-STD-454 for fungus inertness.

3.4.2 Sensing elements. The material for the force summing devices and wetted parts shall be in accordance with table I.

TABLE I. Material.

Sensing element and wetted parts	Steam, oil, freshwater, condensate and other gases	Service fluid		Oxygen
		Seawater	Flue gas and ammonia	
CRES 304L 316L and 321	X	---	X	---
CRES 17-4 PH 17-7 PH 15-5 PH	X	---	---	---
Monel and K-Monel	X	X	---	X
Inconel 600 and X750	X	---	---	---
Inconel 625 and 718	X	X	---	---
Hastelloy C276	X	X	X	---
Titanium CP and 6A1-4V	X	X	---	---
CuNi 70/30	X	X	---	X
Ni Span	X	---	---	---
Tantalum	X	X	---	---

3.4.3 Ranges. Transducer pressure ranges shall be in accordance with table II, as specified (see 6.2).

TABLE II. Ranges.

Type PGT	Type PCT		Type PVT	Type PWT
	Compound ranges			
Pressure ranges (lb/in^2)	Vacuum (in Hg)	Pressure (lb/in^2)	Vacuum ranges (in Hg)	Pressure water column ranges (inches of water column)
0 - 5				
0 - 15	0 - 30	0 - 15	0 - 30	0 - 10
0 - 30	0 - 30	0 - 30		0 - 60
0 - 50				
0 - 60	0 - 30	0 - 100		0 - 150
0 - 75				
0 - 100	0 - 30	0 - 150		0 - 300
0 - 150				
0 - 200				
0 - 300				
0 - 500				
0 - 600				
0 - 1000				
0 - 1500				
0 - 3000				
0 - 5000				
0 - 6000				
0 - 10,000				

3.4.4 Output. The electrical signal output of the transducer shall be dc directly proportional to pressure input. The output shall be a true current source of 4 to 20 milliamperes (mA), dc. The static error band requirement shall be met (see 3.7.1), regardless of external load resistance variations over a range of 0 to 250 ohms. The 4 mA output shall correspond to the lower pressure range value and the 20 mA output shall correspond to the upper pressure range value for the transducer pressure ranges specified in table II.

3.4.5 Power supply. Transducers shall operate in either a two-wire or a four-wire configuration, but not both. The two-wire configuration shall use a 28 volt dc supply. The four-wire configuration shall use a 115 volt ac supply (see 3.5.8).

3.5 Transducer design requirements. Transducers shall have an expected life of 40,000 hours of operation when installed and subjected to the following conditions encountered in Naval service:

(a) High shock (see 4.8.18).
(b) Vibration (see 4.8.17).
(c) Temperature (see 4.8.10).
(d) Humidity (see 4.8.11).
(e) Supply voltage and frequency variations (see 4.8.7 and 4.8.9).
(f) Inclination (see 4.8.6)
(g) Pressure variations in the fluids over the range specified (see 4.8.15).

3.5.1 Calibration monitor. A means shall be provided at the signal conditioner to monitor transducer electrical output corresponding to pressure input, to permit in-place calibration. The monitor signal shall be of an accuracy sufficient to determine the static error band (see 3.7.1 and 6.5) and repeatability (see 3.7.2). The monitoring means may be in the form of test jacks. Monitoring shall be effected without the necessity of electrical disconnection.

3.5.2 Adjustments. Tamper-proof adjustments for zero and span shall be provided for calibration purposes. The number of adjustments shall be kept to a minimum consistent with the operation and maintenance requirements and the elimination of need for selective matching of parts.

3.5.3 Degree of enclosure. Transducers shall be splashproof as specified in MIL-STD-108. There shall be no evidence of water leakage into the equipment enclosure (see 4.8.13).

3.5.4 Transducer mounting. The transducer shall have four mounting bolt holes, each 0.375 inch plus or minus 0.005 inch in diameter. The centers of the mounting bolt holes shall form a rectangular pattern with sides of 3.125 inches plus or minus 0.010 inch (lateral) and 5.375 inches plus or minus 0.010 inch (longitudinal). The thickness of that portion of the mounting base through which the mounting bolts pass shall not exceed 0.50 inch.

3.5.5 External configuration. The transducers external configuration shall conform to the following:

(a) The transducers electrical connector (see 3.5.14) and pressure connection (see 3.5.7) shall be on opposite (longitudinal) ends of the transducer, shall face in opposite directions, and their centers shall be within plus or minus 0.5 inch of the longitudinal centerline of the rectangular pattern formed by the four mounting bolt holes.
(b) Exclusive of the pressure connection for submarine oxygen service (see 3.5.7), the end of the pressure connection shall not be less than 3.0 inches nor more than 5.5 inches from the geometric center of the pattern formed by the four mounting-bolt holes.

(c) The end of the electrical connector shall not be less than 3.0 inches nor more than 5.5 inches from the geometric center of the pattern formed by the mounting-bolt holes.

(d) The center of the opening of the pressure port shall not be less than 1.5 inches nor more than 3.75 inchs from the underside of the mounting base.

(e) The center of the face of the electrical connector shall not be less than 0.75 inch nor more than 3.0 inches from the underside of the mounting base.

(f) The total height of the transducer shall not exceed 6.5 inches.

(g) The total width of the transducer shall not exceed 4.20 inches and neither side shall extend more than 2.10 inches from the geometric center of the pattern formed by the four mounting-bolt holes.

(h) Exclusive of the pressure connection for submarine oxygen service (see 3.5.7), the total length of the transducer, including pressure connection and electrical connector, shall not exceed 9.0 inches.

(i) Without having to unmount the transducer, the zero adjustment, span adjustment, and calibration test points shall be accessible when transducers are installed side-by-side with lateral separations 0.25 inch or less.

3.5.6 Weight. The weight of the transducer shall not exceed 160 ounces.

3.5.7 Pressure connection. Transducer pressure sensing connection for all services shall be in accordance with MS16142. Only 1/4-inch outside diameter (od) tube size shall be used. However, for use on submarine oxygen replenishment systems shown on Drawing 810-1385846, the transducer sensing connection shall be a nickel-copper pipe nipple 1/4 iron pipe size (ips) with 0.120 minimum wall thickness, 6 inches long, welded to the socket in accordance with MIL-STD-278 (see 6.2).

3.5.8 Power supply requirements. Nominal steady-state power supply requirements for ac shall be 115 volts plus or minus 8 volts, 60 Hertz (Hz) plus or minus 2 Hz, single-phase. Nominal steady-state power supply requirements for dc shall be 28 volts plus or minus 4.5 volts. The transducer shall operate with power supply variations as specified in 4.8.7 and 4.8.9.

3.5.9 Reference pressure. Detectors shall be referenced to ambient atmospheric for gauge units, to a vacuum for absolute units, or to 14.7 lb/in^2 absolute for sealed units as specified in 1.2.1.4. Sealed reference shall only be employed for transducers with upper range values of 600 lb/in^2 or greater.

3.5.10 Detector cleaning.

3.5.10.1 Definition. "Clean" shall be defined as being free of all loose scale, rust, grit, filings, and other foreign substances and free of mercury, oil, grease, or other organic materials. The surfaces to be cleaned shall be pressure connection and all parts.

3.5.10.2 Cleaning requirements. Detectors shall be cleaned in accordance with 3.5.10.1. In addition the following shall apply:

(a) Detector for OX service shall be clean gas calibrated, cleaned, and packaged in accordance with MIL-E-17555 (see 5.1).
(b) Detector for GP, SW and FG service shall be clean gas calibrated and pressure connection capped (sealed for shipment).

3.5.10.3 Special marking. Transducers for use with OX and GP shall have "USE NO OIL FOR CALIBRATION" prominently marked on the detector.

3.5.11 Lubrication. Transducer shall operate without need for lubrication of any part after assembly. Primary detecting elements shall have the legend "DO NOT LUBRICATE" prominently marked on the detector.

3.5.12 Welding and brazing. Internal pressure containing parts shall be joined by welding or brazing. Welding shall be in accordance with MIL-STD-278 and brazing in accordance with NAVSHIPS 0900-LP-001-7000.

3.5.12.1 General applications. Joints shall be either welded or microbrazed. Depending on the pressure range, MIL-STD-278, class R1 or P-2 shall apply for welding. Class P-3 shall apply for microbrazing.

3.5.12.2 Oxygen applications. Joints shall be welded for all pressure ranges, MIL-STD-278, class P-1 shall apply.

3.5.13 Damping. The use of oil for damping, as a fill media, and so forth, in transducers for OX and GP applications shall be cited on the equipment drawing.

3.5.14 Electrical connector. An electrical interface connector (receptacle and mating plug) in accordance with MIL-C-5015 shall be provided with each transducer.

3.5.14.1 28 volt dc transducers. The receptacle shall be a MS3102R14S-5P in accordance with MS3102. Receptacle pin "A" shall be positive, pin "B" shall be negative, and pin "C" shall be case ground. The mating plug shall be a MS3106F14S-5S in accordance with MS3106. The MS3102 receptacle may be designed to include built-in radio frequency (RF) suppression elements.

3.5.14.2 115 volt ac transducers. The receptacle shall be a MS3102R14S-5PX in accordance with MS3102. Receptacle pins "A" and "B" shall be 115 volts ac input, pin "C" shall be case ground, pin "D" shall be positive (4 to 20 mA dc output) and pin "E" shall be negative (4 to 20 mA dc output). The mating plug shall be a MS3106F14S-5SX in accordance with MS3106. The MS3102 receptacle may be designed to include built-in RF suppression elements.

3.5.15 Label plate. A metallic label plate with engraved or stamped markings shall be permanently affixed to the outside of each pressure transducer. The label plate shall not be placed on the underside of the mounting surface or on any portion, such as an access cover, which may be separated from the body of the pressure transducer. As a minimum, the label plate shall contain the following information:

(a) Pressure transducer
(b) Manufacturers name
(c) Manufacturers part number
(d) Contract number
(e) Date of manufacture
(f) Serial number
(g) Government designation (see 1.2.1)
(h) Pressure range

3.6 Detail requirements.

3.6.1 Fuses. The equipment shall not be fused.

3.6.2 Semiconductors. Silicon rectifiers, diodes, transistors, and other semiconductor devices shall be in accordance with MIL-S-19500 and shall be selected from MIL-STD-701. Devices other than those listed in MIL-STD-701 shall be used only where specifically approved in writing by NAVSEA on the basis of justification submitted in accordance with MIL-M-38510.

3.6.3 Electron tubes. Electron tubes shall not be used.

3.6.4 Modular assemblies. The configuration of power supplies, signal conditioners, and other circuitry separate from the detector shall meet the modular construction requirements specified in 3.6.4.1, 3.6.4.2, and 3.6.4.3.

3.6.4.1 Construction. Module thickness, packaging configuration, potting, and encapsulation shall be subject to development by the contractor.

3.6.4.2 Plug-in units. Plug-in module units may include, but are not limited to, printed circuit boards for conventional components, cable connectors, power supplies, and integrated microelectronic circuits.

3.6.4.3 Accessibility. Modular units or assemblies shall be fastened in such a manner to allow for quick and easy removal for maintenance, accessibility, or replacement.

3.6.5 Printed wiring boards. Printed wiring boards shall be in accordance with MIL-STD-275 and MIL-P-55110.

3.6.6 Resistors. Composition type fixed or variable resistors shall not be used.

3.7 Transducer performance. Performance tolerances are specified in percent of transducer output span.

3.7.1 Static error band. Transducer static error band shall not exceed plus or minus 1 percent (see 4.8.1).

3.7.2 Repeatability. Repeatability of transducer output shall be within 0.5 percent (see 4.8.1).

3.7.3 Sensitivity factor. The values of the ratio of electrical output percentage change to pressure input percentage change shall not be less than 0.80 or more than 1.20 (see 4.8.3).

3.7.4 Ripple. Transducer root mean square (rms) output ripple shall not exceed 0.15 percent of full scale output (see 4.8.4).

3.7.5 Warm-up time. Transducer output shall attain a value within plus or minus 1 percent of the steady-state output with no overshoot in excess of 1 percent. Output shall reach this band in 15 minutes or less and shall remain in this band (see 4.8.5).

3.7.6 Inclination. Maximum deviation of the transducer output resulting from inclination shall not exceed 3.0 percent for transducers with upper range values exceeding 60 inches of water column, and 4.0 percent for transducers with upper range values of 60 inches of water column and below (see 4.8.6).

3.7.7 Supply voltage and frequency or supply voltage (for dc) (steady-state). Maximum difference between outputs at any voltage and frequency or voltage (for dc) condition and the normal (115 volts, 60 Hz or 28 volts dc) at the same input, pressure and ambient temperature shall not exceed 1.0 percent (see 4.8.7).

3.7.8 Response (see 4.8.8). Transducer output shall conform to the following criteria, where all percentages are of transducer span:

(a) Transducer output shall be within plus or minus 2 percent of maximum ramp pressure within 0.01 second of the time that pressure is attained.
(b) Transducer output shall exhibit no overshoot of maximum ramp pressure in excess of 2.0 percent.

(c) Transducer output shall indicate the actual pressure to within plus or minus 1.0 percent in 0.15 second or less after attainment of maximum ramp pressure, and shall remain within this error band for the duration of the applied steady-state pressure.

3.7.9 Supply voltage and frequency or supply voltage (for dc) transients (see 4.8.9).

3.7.9.1 Voltage. During the voltage transient test the transducer output shall remain within plus or minus 5 percent of the steady-state output.

3.7.9.2 Frequency. During the frequency transient test the transducer output shall remain within plus or minus 0.5 percent of the steady-state output.

3.7.10 Temperature. During the temperature test, transducer performance shall be within the static error band specified in 3.7.1 (see 4.8.10).

3.7.11 Humidity. Maximum deviation of the second cycle reference measurement from the post-conditioning calibration shall not exceed 1.5 percent. After temperature cycling, performance shall conform to 3.7.1 and shall show no evidence of damage (see 4.8.11).

3.7.12 Overpressure. Calibration conducted after overpressure test shall have no values in excess of 1 percent deviation from the preoverpressure test calibration. After calibration the transducer shall be capable of being adjusted to accuracy requirements of 3.7.1 (see 4.8.12).

3.7.13 Salt spray. No appreciable corrosion or other damage, either mechanical or electrical, shall be evident after the salt spray test. There shall be no evidence of saltwater leakage into the equipment enclosure. After completion of the test, performance shall conform to 3.7.1 (see 4.8.14).

3.7.14 Pressure whip. Calibration conducted after completion of pressure whip test shall have no values in excess of 1 percent deviation from pretest reference measurement (see 4.8.15).

3.7.15 Insulation resistance. The insulation resistance of the transducer equipment between circuits and between circuits and ground shall be not less than 10 megohms (see 4.8.16).

3.7.16 Vibration. Monitored transducer output during all phases of vibration test shall show no variation from steady-state output in excess of 2.0 percent (see 4.8.17). There shall be no evidence of damage to the transducer as a result of the vibration test.

3.7.17 Shock. The transducer shall continue to operate through and after the shock test. After the shock test, but prior to any adjustment, the transducer output shall show no deviation greater than 3 percent for transducers with upper range values exceeding 60 inches water column, and 4.0 percent for transducers with upper range values of 60 inches water column and below. A post

test calibration using adjustments provided, shall conform to performance requirements of 3.7.1. There shall be no evidence of damage to the transducer as a result of the shock test (see 4.8.18).

3.7.18 Burst pressure. Transducer shall withstand the burst pressure specified in 4.8.19 without showing any evidence of leakage.

3.7.19 Electromagnetic interference emission and susceptibility (EMI). The pressure transducers shall meet the following requirements of MIL-STD-461: CE01, CE03, CS01, CS02, CS06, CS09, RE01, RS02, RS03, except as modified below:

(a) Requirement CS02 shall be met as specified except as follows:

(1) At frequencies between 2 MHz and 30 MHz, the full output of the generator (source impedance of 50 ohms, and an output capability of 12.25 volts rms, or 3 watts, when connected to a 50-ohm load) shall be applied to all power and signal leads of the test sample.
(2) The "calibrating resistor", or 50-ohm load, as specified in MIL-STD-462, shall not be connected during the test.
(3) The test sample output shall not vary more than 1.0 percent of transducer span.

(b) Requirement of RS03 shall be met as specified except as follows:

(1) Between the frequencies of 14 kHz and 18 GHz, the electric field strength test level shall be 10 V/M.

(c) Requirement CS06 shall be met as specified except as follows:

(1) The test signal shall be applied only to ac power leads of the test sample.

(d) Requirements CE01 and CE03 shall be met as specified except as follows:

(1) The emission signal shall be measured only on ac power leads of the test sample.

3.8 Workmanship. Workmanship for pressure transducers shall conform to requirement 9 of MIL-STD-454.

3.9 Drawings. (See 6.3 and Appendix).

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use

his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractors overall inspection system or quality program (see 6.3). The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of the manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Classification of inspections. This inspection requirements specified herein are classified as follows:

(a) Qualification inspection (see 4.3).
(b) Quality conformance inspection (see 4.4).
(c) Periodic tests (see 4.5).

4.3 Qualification inspection. Qualification inspection shall be conducted at a laboratory satisfactory to NAVSEA. Qualification inspection shall be as specified in table III and shall be conducted in the order listed. Except for electromagnetic interference emission and susceptibility, all examinations and tests shall be conducted utilizing a single transducer, one for each range (see 4.3.1), and in the order listed in table III. The electromagnetic interference emission and susceptibility test may be conducted on a separate transducer of the same design and pressure range. In addition, this test may be conducted concurrently with any of the other examinations and tests listed in table III. Deviations from the above procedures require approval of NAVSEA.

TABLE III. Qualification inspection.

Inspection	Requirement	Inspection
General examination	3.4	4.6
Output	3.4.4	4.8.20
Warm-up time	3.7.5	4.8.5
Enclosure	3.5.3	4.8.13
Salt spray	3.7.13	4.8.14
Static error band and repeatability	3.7.1 and 3.7.2	4.8.1
Sensitivity factor	3.7.3	4.8.3
Ripple	3.7.4	4.8.4
Inclination	3.7.6	4.8.6

TABLE III. Qualification inspection. (Continued)

Inspection	Requirement	Inspection
Supply voltage and frequency (steady-state)	3.7.7	4.8.7
Response	3.7.8	4.8.8
Supply voltage and frequency (transient)	3.7.9	4.8.9
Temperature	3.7.10	4.8.10
Humidity	3.7.11	4.8.11
Overpressure	3.7.12	4.8.12
Pressure whip	3.7.14	4.8.15
Insulation resistance	3.7.15	4.8.16
Vibration	3.7.16	4.8.17
Shock	3.7.17	4.8.18
Burst pressure	3.7.18	4.8.19
Electromagnetic interference emission and susceptibility	3.7.19	4.8.21

4.3.1 Samples for qualification. The number of samples to be submitted for the qualification inspection specified in table III shall depend on the transducer design. If each range is covered by a separate and distinct design, a sample for each range will require testing. In instances where a singular design series may cover several ranges and types, only one sample need be submitted for testing provided the electrical and mechanical similarities are approved by NAVSEA. In no case, however, shall less than three units, one unit each representing low (0 to 99 lb/in^2), mid (100 to 999 lb/in^2) and high (1000 to 10,000 lb/in^2) ranges, be submitted for qualification testing, regardless of design similarity. Successful passage of the qualification tests by each representative sample shall qualify that design for that discrete range; that is, low, mid or high.

4.3.2 Authorization for qualification tests. Prior to authorization of qualification tests, the contractor shall submit complete mechanical and electrical drawings and two copies of the proposed test procedures to NAVSEA for approval. Approval shall be required only on the first submittal of an item and whenever changes are made.

4.3.3 Retention of qualification. To retain qualification, the contractor shall forward a report at 12-month intervals to the qualifying activity. The qualifying activity shall establish the initial reporting date. The report shall consist of:

(a) A summary of the results of the tests performed for inspection of product for delivery, indicating as a minimum the number of lots that have passed, the number that have failed, and the

group which they failed. The results of tests of all reworked lots shall be identified and accounted for.

(b) A summary of the results of tests performed for periodic inspection, including the number and mode of failures. The summary shall include results of all periodic inspection tests performed and completed during the 12-month period. If the summary of the test results indicates nonconformance with specification requirements and corrective action acceptable to the qualifying activity has not been taken, action may be taken to remove the failing product from the qualified products list.

Failure to submit the report within 30 days after the end of each 12-month period may result in loss of qualification for the product. In addition to the periodic submission of inspection data, the contractor shall immediately notify the qualifying activity at any time during the 12-month period that the inspection data indicated failure of the qualified product to meet the requirements of this specification. In the event that no production occurred during the reporting period, a report shall be submitted certifying that the company still has the capabilities and facilities necessary to produce the item. If during two consecutive reporting periods there has been no production, the contractor may be required, at the discretion of the qualifying activity, to submit his qualified products to testing in accordance with the qualification inspection requirements and the reason for no production.

4.3.4 Inspection lot. An inspection lot shall consist of all transducers of each basically similar design produced under essentially the same conditions, and offered for inspection at the same time.

4.4 Quality conformance inspection. Each transducer in each lot offered for delivery shall be subjected to the inspection listed in table IV and shall be conducted in the order listed. Failure of any transducer to meet the examination or any test shall result in rejection of that transducer.

TABLE IV. Quality conformance inspection.

Inspection	Requirement	Inspection
General examination	3.4	4.6
Output	3.4.4	4.8.20
Static error band and repeatability	3.7.1 and 3.7.2	
Overpressure	3.7.12	4.8.12
Insulation resistance	3.7.15	4.8.16

4.5 Periodic tests. Three transducers shall be selected at random out of every 100 transducers which have satisfactorily passed the tests specified in 4.4, from each lot offered for delivery and shall be subjected to the tests listed in

table V. If any transducer fails in any test, that lot of transducers shall not be accepted for quality conformance inspection until the manufacturer has determined the cause of the defect and has taken the necessary action to correct or eliminate the defects from all units on hand. The failed test and any other periodic test required by the Government shall be repeated to demonstrate that the corrective action will enable the transducer to conform to the requirements of this specification. All design changes based on test results require NAVSEA approval and certification, respectively. Samples which have satisfactorily passed the examination and tests listed in table V may not be applied as part of the quantity specified (see 6.2 and 6.3).

TABLE V. Periodic tests.

Tests	Requirement	Test
Inclination	3.7.6	4.8.6
Supply voltage and frequency (steady-state)	3.7.7	4.8.7
Temperature	3.7.10	4.8.10
Burst pressure	3.7.18	4.8.19

4.6 General examination. Transducer shall be given a thorough examination to determine compliance to the requirements of this specification with respect to material, finish, workmanship, construction (including detail requirements, see 3.6), assembly, mounting, external configuration, weight, pressure and electrical connections, cleaning, lubrication, marking of identification and information plates. Examination shall be limited to the examinations that may be performed without disassembling the unit in such a manner that its performance, durability, or appearance would be affected. Examination shall also include a check of all operation controls and adjustments, as applicable.

4.7 Test conditions. Except where the following factors are the variables, the tests specified in 4.8 shall be conducted with the equipment operating under the following conditions:

(a) Ambient temperature shall be 25°C ± 2°C.
(b) Relative humidity shall be ambient.
(c) Supply voltage shall be 115 volts (nominal for power supply designation 4 or 28 volts (nominal) for power supply designation 2.
(d) Supply frequency shall be 60 Hz (nominal) for power supply designation 4 or direct current for power supply designation 2.
(e) Controls shall be in the neutral or normal position.
(f) Specified external load (see 3.4.4).

4.8 Tests. Except for the warm-up time test (see 4.8.5), the transducer and all associated test equipment shall be energized for a period of time sufficient to ensure complete warm-up.

4.8.1 Static error band and repeatability. Transducer shall first be flexed over its full pressure range by slowly increasing and decreasing the applied pressure for six continuous cycles. The calibration measurement shall be made at a minimum of five equally spaced intervals over the entire range (both upscale and downscale). Precaution shall be taken to avoid overshoot. This calibration procedure shall be applied three successive times to determine repeatability. Static error band of all calibrations shall meet the requirements of 3.7.1. Repeatability shall meet the requirements of 3.7.2.

4.8.2 Reference measurement. The following reference measurement shall be conducted when specified in the individual test:

(a) A one trial calibration with at least five equally spaced intervals over the entire transducer range both upscale and downscale.

4.8.3 Sensitivity factor. The sensitivity factor shall be determined as follows: Pressurize the transducer to a value of 80 percent plus or minus 5 percent of span. Record the input pressure and corresponding electrical output. Increase the pressure by an amount not exceeding 1.00 percent of span. Record both the new pressure and corresponding new electrical output. Calculate the change in both applied pressure and electrical output as a percentage of transducer span. Determine the ratio of the electrical output percentage change to applied pressure percentage change. Repeat this procedure for a pressure decrease not exceeding 1.00 percent of span. Performance shall conform to the requirements of 3.7.3.

4.8.4 Ripple. Rms ripple shall be determined at an input pressure of 80 ± 5 percent of transducer span. Performance shall conform to the requirements of 3.7.4.

4.8.5 Determination of warm-up time. Test shall be conducted to determine the elapsed time between the application of line power to a transducer which has not been warmed up and the point at which the transducer output reaches the conditions specified in 3.7.5.

4.8.5.1 Test conditions. Transducer shall be placed in an ambient temperature of 25°C ± 2°C for not less than 2 hours deenergized. Recording equipment and other auxiliary equipment shall be energized to assure complete warm-up. An input pressure of 80 ± 5 percent of the span shall be applied to the transducer and maintained constant during this test. Performance shall conform to the requirements of 3.7.5.

4.8.6 Inclination.

4.8.6.1 Prior to any inclination, a reference measurement in accordance with 4.8.2 shall be made with the transducer in each of the following orientations:

(a) Mounting surface horizontal.
(b) Mounting surface vertical with pressure connection vertically downward.

4.8.6.2 From each of the mounting orientations of 4.8.6.1, the transducer shall be inclined for at least 1 minute in each of the following positions and a reference measurement in accordance with 4.8.2 shall be made. Performance shall conform to the requirements of 3.7.6.

(a) 45 degrees from the vertical forward.
(b) 45 degrees from the vertical backward.
(c) 45 degrees from the vertical to the left.
(d) 45 degrees from the vertical to the right.

4.8.7 Supply voltage and frequency or supply voltage (for dc) (steady-state). Transducer shall be operated at the configurations of normal, maximum, and minimum steady-state voltages and frequencies specified in 3.5.8. The ambient temperature shall also vary with the transducer operated for at least 15 minutes at each test temperature prior to the first reference measurement. The transducer shall be allowed at least 15 minutes to stablize at each configuration after which a reference measurement shall be taken (see 4.8.2). Reference measurements shall be performed at ambient temperatures of 0°C ± 2°C, 25°C ± 2°C, and 65°C ± 2°C. Test temperatures shall be accomplished by varying temperature in steps of 10°C each (30 minutes per step) until the desired ambient temperature is reached. Performance shall conform to the requirements of 3.7.7.

4.8.8 Response. A pressure ramp consisting of a pressure rise of at least 40 percent of transducer span occurring at a rate of not less than 400 percent per second shall be applied to the transducer. The maximum ramp pressure shall be maintained for at least 0.75 second and shall not vary by more than plus or minus 2 percent of transducer span. Performance shall conform to the requirements of 3.7.8.

4.8.9 Supply voltage and frequency or supply voltage (for dc) (transient). Tests specified in 4.8.9.1 and 4.8.9.2 shall be conducted with a pressure input signal equal to 80 ± 5 percent of the transducer span. Performance shall conform to the requirements of 3.7.9.

4.8.9.1 Transient voltage.

4.8.9.1.1 Upper limit of steady-state voltage. With the transducer operating at the upper limit of steady-state ac voltage, the ac powered transducer shall have a transient voltage of plus 15 volts recovering to the steady-state band in 2 seconds superimposed. With the transducer operating at the upper limit of steady-state dc voltage, the dc powered transducer shall have a transient voltage of plus 2.0 volts recovering to the steady-state band in 2 seconds superimposed.

4.8.9.1.2 Lower limit of steady-state voltage. With the transducer operating at the lower limit of steady-state ac voltage, the ac powered transducer shall have a transient voltage of minus 15 volts recovering to the steady-state band in 2 seconds superimposed. With the transducer operating at the lower limit of steady-state dc voltage, the dc powered transducer shall have a transient voltage of minus 2.0 volts recovering to the steady-state band in 2 seconds superimposed.

4.8.9.2 Transient frequency (for ac powered transducers).

4.8.9.2.1 Upper limit of steady-state frequency. With the transducer operating at the upper limit of steady-state frequency, a transient frequency of plus 1.5 Hz recovering to the steady-state band in 2 seconds shall be superimposed.

4.8.9.2.2 Lower limit of steady-state frequency. With the transducer operating at the lower limit of steady-state frequency, a transient frequency of minus 1.5 Hz recovering to the steady-state band in 2 seconds shall be superimposed.

4.8.10 Temperature. Transducer shall be capable of normal operation (without alignment or adjustment) throughout the following temperature cycle; tolerances in operating characteristics shall be as specified herein:

(a) Hold room temperature at 0°C ± 2°C for at least 24 hours.
(b) Increase room temperature in steps of 10 degrees each, at 30 minutes per step, until +65°C ± 2°C is reached, and hold at that temperature for at least 4 hours.
(c) Reduce room temperature in steps of 10 degrees each, at 30 minutes per step, until +25°C ± 2°C is reached, and hold at that temperature for at least 4 hours.

At each temperature plateau (0°C, 65°C and 25°C), a reference measurement (see 4.8.2) shall be made. Performance shall conform to the requirements of 3.7.10.

4.8.11 Humidity. Transducer shall be subjected to the conditioning and tests specified in 4.8.11.1 through 4.8.11.5.1. Except for the periods of tests specified in 4.8.11.1 through 4.8.11.5.1, the equipment shall not be energized. Performance shall conform to the requirements of 3.7.11.

4.8.11.1 Conditioning. In order to establish a reference condition for the measurement of operating parameters and a valid basis for comparison of the effects of the conditioning to follow, the complete equipment shall be dried at a temperature not less than 40°C nor more than 50°C for at least 2 hours.

4.8.11.2 Reference measurements. Following the conditioning specified in 4.8.11.1, a reference measurement in accordance with 4.8.2 to indicate the satisfactory performance of the transducer shall be conducted at 25°C ± 5°C and 50 ± 5 percent relative humidity.

4.8.11.3 Temperature cycling. Transducer shall then be subjected to four 24-hour cycles of temperature variation consisting of 18 hours at 65°C ± 5°C and 6 hours at 25°C ± 5°C. The relative humidity shall be maintained above a minimum of 95 percent during the steady-state conditions. The transitions between temperatures shall be accomplished within the 6-hour period so that the time at the high temperature is 18 hours. Each transition shall not exceed 1 hour if the transducer remains in the chamber, or 15 minutes if a two chamber method is employed. The relative humidity need not be controlled during the transition periods.

4.8.11.4 Measurement during cycling. During the second cycle, the measurements required in 4.8.2 shall be performed at 65°C ± 5°C prior to the decrease of temperature to 25°C with the transducer remaining in the chamber. The transducer shall be energized for as brief a period as required to complete the measurements. A warm-up period may be permitted where previous tests indicate a definite period is required for the transducer to attain thermal stability.

4.8.11.4.1 Requirements of transducer. Transducer shall be capable of meeting the requirements specified herein without alignment or adjustment, other than the accessible controls employed for operation of the equipment. No repairs shall be permitted prior to measurement. If repairs are required, the test specified in 4.8.11.3 shall be repeated, after the necessary replacements have been made.

4.8.11.5 Measurements after temperature cycling. After the four complete cycles, the measurements required in 4.8.11.3 shall be performed at 25°C ± 5°C with the transducer remaining in the chamber. The transducer shall meet the requirements of this specification with no readjustments.

4.8.11.5.1 Additional tests. Upon completion of the tests, and after remaining inoperative for not less than 12 hours nor more than 24 hours at a temperature of 25°C ± 5°C and 50 percent plus or minus 5 percent relative humidity, any additional tests or measurements considered necessary by the Government shall be made to determine conformance to the requirements specified herein. In addition, the transducer shall be examined to detect evidence of physical degradation such as corrosion of metal parts or distortion of plastic parts. When it is necessary to replace parts to obtain satisfactory transducer performance, the filed part or parts shall be analyzed to determine the cause of unsatisfactory operation. Unsatisfactory parts or materials shall be replaced by adequate substitutes.

4.8.12 Overpressure. Prior to the overpressure test, a reference measurement in accordance with 4.8.2 shall be made. Types PGT and PWT transducers shall successfully withstand pressure equal to 200 percent of their range with a maximum pressure of 10,000 lb/in^2 (for the 10,000 lb/in^2 range maximum pressure shall be 15,000 lb/in^2) for a period of 1/2 hour. At the end of this period, transducers shall be immediately subjected to a pressure equal to 1 lb/in^2 or 10 percent of range, whichever is less, below atmospheric for an additional period of 1/2 hour. Type PVT transducers shall successfully withstand a vacuum of 29.9 in Hg for a period of 1 hour. Type PCT transducers shall be subjected to both tests. Within 10 minutes after release of this pressure a reference measurement (see 4.8.2) shall be made for comparison. Performance shall conform to the requirements of 3.7.12. After the test the check specified in 4.8.1 shall be performed.

4.8.13 Enclosure. The enclosures shall be subjected to the splashproof test conditions specified in MIL-STD-108. Performance shall conform to the requirements of 3.5.3.

4.8.14 Salt spray. The salt spray test shall be conducted in accordance with method 101 of MIL-STD-202 using a 20 percent salt solution. Duration of the test shall be 100 hours. The internals of the signal conditioner and power supply shall not be subjected to the test. When any transducer component is physically attached to the detector, the integral component shall also be tested. If the transducer is not designed for seawater service, the inlet pressure connection shall be plugged. Performance shall conform to the requirements of 3.7.13.

4.8.15 Pressure whip. Prior to pressure whip test a reference measurement shall be made (see 4.8.2). The test shall be conducted on a suitable system capable of applying a sinusoidal pressure change of at least 60 percent of span with the minimum pressure below 20 percent of span and maximum pressure above 80 percent of span for a total of 260,000 cyles. The rate of cycling shall be one Hz. The transducer shall be energized throughout the test. After completion of the pressure whip test a reference measurement shall be made for comparison (see 4.8.2). Performance shall conform to the requirements of 3.7.14.

4.8.16 Insulation resistance. The insulation resistance of the transducer shall be determined by applying 50 volts dc between electrical input and output circuits and between these circuits and ground. The temperature shall be 25 ± 5°C and the relative humidity shall be 50 ± 10 percent. The insulation resistance measurement shall be made immediately after a 2-minute period of uninterrupted test voltage application. However, if the indication of insulation resistance meets the specified limit, (see 3.7.15), and is steady or increasing, the test may be terminated before the end of the 2-minute period.

4.8.17 Vibration. The transducer shall be tested in accordance with type I (environmental) vibration of MIL-STD-167-1 except that the upper frequency shall be 175 Hz; the amplitude of vibration shall be in accordance with table VI; and for the variable frequency portion, the vibration level shall be maintained for 2 minutes at each integral value of frequency. If no resonances are observed, the 2-hour endurance test shall be conducted at 175 Hz. During the vibration test, a fluid pressure of 80 ± 5 percent of the transducer span shall be applied to the transducer. Transducer output during the test shall be monitored. Performance shall conform to the requirements of 3.7.16.

TABLE VI. Amplitudes of vibration.

Frequency range Hz	Table amplitude (inches)	
	Exploratory	Variable frequency
5 to 20	0.010 + 0.002	0.030 + 0.006
21 to 50	0.004 + 0.001	0.020 + 0.004
51 to 100	0.0015 + 0.0003	0.010 + 0.002
101 to 175	0.0005 + 0.0001	0.0015 + 0.0003

4.8.18 Shock tests. The shock tests shall be conducted in accordance with grade A, class I, type C using bulkhead mounting fixture 4-A of MIL-S-901. During the test, a liquid pressure input equal to 80 ± 5 percent of the transducer span shall be applied to the transducer. Transducer output during the test shall be recorded. The output during and after the tests shall be within the allowable limits of 3.7.17. Reference measurements shall be made before and after the shock test (see 4.8.2) and prior to any adjustment of the transducer. Performance shall conform to the requirements of 3.7.17.

4.8.19 Burst pressure. Transducer shall be subjected to a liquid pressure equal to 300 percent of the range with a maximum pressure of 10000 lb/in^2 (for the 10,000 lb/in^2 range, maximum pressure shall be 15,000 lb/in^2) for a period of 10 minutes. The transducer shall conform to the requirements of 3.7.18. Performance requirements are not required to be met after completing the burst test. However, a reference measurement (see 4.8.2) shall be recorded before and after the test for comparison to determine if malfunction resulted. Performance shall conform to the requirements of 3.7.18.

4.8.20 Output. A reference measurement shall be made in accordance with 4.8.2. Performance shall conform to the requirements of 3.4.4.

4.8.21 EMI tests. EMI tests shall be in accordance with the test methods specified in MIL-STD-462, with the modifications as specified in 3.7.19. Performance shall be as specified in 3.7.19.

4.9 Inspection of packaging. Sample packs, and the inspection of the preservation, packing and marking for shipment, stowage, and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition. For the extent of applicability of the packaging requirements of referenced documents listed in section 2, see 6.8.)

5.1 Packaging requirements. Transducer equipment shall be individually preserved level A, C, or commercial, packed level A, B, C, or commercial as specified (see 6.2), marked (including bar coding) in accordance with MIL-E-17555, and shall include acquisition options therein as specified (see 6.2). The transducer components shall be packaged as a single unit. Unless otherwise specified (see 6.2), method III shall apply for level A preservation. In addition, for Navy acquisitions, the following applies:

(a) Navy fire-retardant requirements.

(1) Lumber and plywood. Unless otherwise specified (see 6.2), all lumber and plywood (including laminated veneer material used in shipping container construction members, blocking, bracing, and reinforcing) shall be fire-retardant treated material conforming to MIL-L-19140 as follows:

Levels A and B - Type II - weather resistant.
Category 1 - general use.
Level C - Type I - non-weather resistant.
Category 1 - general use.

(2) Fiberboard. Unless otherwise specified (see 6.2), fiberboard used in the construction of interior (unit and intermediate) and exterior boxes, including interior packaging forms, shall conform to the class domestic/fire retardant or class weather resistant/fire retardant materials requirements of PPP-F-320 and amendments thereto.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. Transducers are intended to provide control input and monitoring of pressures for shipboard engineering plants.

6.2 Acquisition requirements. Acquisition documents must specify the following:

(a) Title, number, and date of this specification.
(b) Type designation required (see 1.2.1).
(c) Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1, 2.1.2 and 2.2).
(d) Transducer pressure range (see 3.4.3).
(e) Type of pressure connection if different than specified (see 3.5.7).
(f) Quantity of transducers required (see 4.5).
(g) Level of preservation and packing required (see 5.1).

6.3 Consideration of data requirements. The following data requirements should be considered when this standard is applied on a contract. The applicable Data Item Descriptions (DIDs) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DIDs are tailored to reflect the requirements of the specific acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DOD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423.

Reference paragraph	DID number	DID title	Suggested tailoring
3.9	DI-DRPR-80651	Drawings engineering	-----
4.1.1, 4.5	DI-NDTI-80604	Test report	-----

The above DIDs were those cleared as of the date of this standard. The current issue of DOD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), must be researched to ensure that only current, cleared DIDs are cited on the DD Form 1423.

6.3.1 Technical manuals. The requirement for technical manuals should be considered when this specification is applied on a contract. If technical manuals are required, military specifications and standards that have been cleared and listed in DOD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL) must be listed on a separate Contract Data Requirements List (DD Form 1423), which is included as an exhibit to the contract. The technical manuals must be acquired under separate contract line item in the contract.

6.4 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL No. 24212 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or pruchase orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362-5101 and information pertaining to qualification of products may be obtained from that activity.

6.5 Definitions. Terminology consistent with Instrument Society of America Recommended Practice 37.1 shall apply, except as modified by the definitions listed as follows:

(a) Deadband. The range through which the measurand can be varied without a change in transducer output.
(b) Static error band. The maximum deviation from a straight line drawn through the coordinates of the lower span limit at specified transducer output, and the upper span limit at specified transducer output expressed in percent of transducer range.

6.6 Calibration system requirements. When specified in the contract or purchase order, equipment calibration procedures should be prepared.

6.7 Provisioning. Provisioning Technical Documentation (PTD), spare parts, and repair parts should be furnished as specified in the contract.

6.7.1 When ordering spare parts or repair parts for the equipment covered by this specification, the contract should state that such spare parts and repair parts should meet the same requirements and quality assurance provisions as the parts used in the manufacture of the equipment. Packaging for such parts should also be specified.

6.8 Sub-contracted material and parts. The preparation for delivery requirements of referenced documents listed in section 2 do not apply when material and parts are procured by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

6.9 Subject term (key word) listing.

Detectors
Output ripple
Range
Sensing
Sensitivity factor

6.10 International interest. Certain provisions of this specification (see 3.4.3, 3.4.4 and 3.4.5) are the subject of international standardization agreement STANAG 4286. When amendment, revision, or cancellation of this specification is proposed which will modify the international agreement concerned, the preparing activity will take appropriate action through international standardization channels including departmental standardization offices to change the agreement or make other appropriate accommodations.

6.11 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Preparing activity:
Navy - SH
(Project 6685-N857)

Engineering Drawings Technical Content Requirements

10. SCOPE

10.1 Scope. This appendix contains the format and content preparation instructions for the development of and revision to a conformance verification drawing. It is not intended that each requirement contained herein should be applied to every type of instrumentation. Portions of this appendix are subject to deletion tailoring depending upon the material, construction and principle of operating requirements that are specified in the individual instrumentation specification or acquisition document. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

20.1 Government documents.

20.1.1 Specifications and standards. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

MILITARY
MIL-I-45208 - Inspection System Requirements.

STANDARDS

MILITARY
MIL-STD-17-1 - Mechanical Symbols (Other Than Aeronautical, Aerospacecraft and Spacecraft Use) Part-1.

(Unless otherwise indicated, copies of military specifications and standards are available from the Standardization Document Order Desk, BLDG 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

20.2 Non-Government publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS shall be the issue of the documents cited in the solicitation (see 6.2).

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

Y14.1 - Drawing Sheet Size and Format.
IEEE 200 - Standard Reference Designations for Electrical and Electronics Parts and Equipment.

(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, NY 10019.)

(Non-Government standards are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

30. CONFORMANCE VERIFICATION DRAWING FOR INSTRUMENTATION

30.1 Purpose. The conformance verification drawing contains the information necessary to verify that the instrumentation meets the requirements specified in the applicable instrumentation specification and acquisition document.

30.2 Content and format. One conformance verification drawing shall be developed for each specific type of instrumentation. It shall include all ranges, sizes, connections and other variations. The conformance verification drawing shall include the following minimum information (except as specified in 10.1) and shall be developed to the following format:

30.3 Descriptive data.

A. Instrument identification numbering system for instrumentation. This numbering system shall include, but may not be restricted to, the classification variables.
B. Instrumentation identification number system for replaceable parts.
C. Size, operating data, ranges, scale markings, and other data for proper selection.
D. Test approval data, presenting the following information in tabular form.

    1. Specification classification (unique alphanumeric variables to designate instruments).
    2. Test report number and date.
    3. Facility where test was conducted.
    4. Authorized Government activity (NAVSEA) approval letter and date.

E. A statement that instrumentation is in accordance with the requirements of the applicable instrumentation specification or acquisition document and to referenced specifications.
F. Conformance verification drawing acceptance data, presenting the following information in tabular form:

    1. Authorized Government activity (NAVSEA) acceptance letter and date.
    2. Revision number.

30.4 Details of construction.

A. Two or more representative assembly views, as required, to show clearly the details of the design, construction, and assembly of the instrumentation and to identify each part and its location. Identification of parts shall correspond to the list of materials. Assembly shall show how all mechanical parts are joined or attached.
B. Sectional views or notes as necessary to show internal details.
C. Details such as entrance provisions, gaskets, fastening techniques, welding symbols, mounting requirements, and other details as applicable.
D. Module enclosure requirements for separately mounted modules.
E. Dimensions required to ensure interchangeability.
F. Schematic of indicating system.
G. Description of the nature and purpose of any adjustments.
H. Welding procedures with acceptance data, including acceptance letter report numbers and dates.
I. Any special features.
J. Complete weight.
K. Location, size, and type of connections.
L. Identification of quality control documents which show conformance with MIL-I-45208 or the quality control specification that is listed in the applicable instrumentation specification or acquisition document. The acceptance letter shall be referenced.

30.5 Parts list. The following information shall be presented in tabular form:

A. Item number (corresponding to flag number identifying the part on the conformance verification drawing).
B. Quantity of each part required per assembly.
C. Name of part with sufficient information to readily identify the part (for example, screws: thread size, length and type of head, shall be specified).
D. Material of part.
E. Material specification (military, federal, or commercial specification number or government activity (NAVSEA) drawing number).

NOTE: When substitution of a material specification is made, it is the responsibility of the contractor to provide written documentation to substantiate that the substituted material is equivalent to the specified material.

F. Type, class, grade, size, military designation, or other classification of any referenced specification.
G. Part number or identification assigned by assembly supplier.
H. Name of actual manufacturer of part (when applicable).

I. Part number or identification assigned by part supplier (when applicable).
J. Onboard repair parts. Parts that are appropriate for, or are supplied as, onboard repair parts shall be indicated by a symbol in this column.
K. Remarks column. Finishes, platings, or coatings along with the applicable specification or other requirements should be specified in this column.

30.6 Table for special tools. Special tools required for the instrumentation shall be presented in the following tabular form:

A. Item number (corresponding to flag number identifying the tool on the conformance verification drawing).
B. Quantity of each tool required per instrument.
C. Name (description) of tool (include generic name).
D. Tool specification (military, federal, or commercial specification number or government activity (NAVSEA) drawing number).
E. Tool number or identification assigned by assembly supplier.
F. Name of actual manufacturer of tool (when applicable).
G. Tool number or identification assigned by tool supplier (when applicable).
H. Description of tools application.
I. Remarks column. Special techniques or other usage requirements should be explained in this column.

30.7 Fluid and electrical system schematics. Fluid (piping) and electrical schematics shall be included in the verification conformance drawing when applicable. A complete schematic shall contain all the parts in the fluid or electrical systems. When confusion over its function could result, a simplified schematic containing only the major components shall also be provided. This simplified schematic may be presented in block diagram format.

A. Complete fluid system schematic. A single schematic shall present clearly the operation and functions of the fluid system within the instrumentation. This schematic shall contain all parts (including valves, fittings, hoses, and tubing) which make up the piping or fluid system. The following features shall be incorporated into the schematic:

1. A simplified, clear schematic in preference to one showing the physical placement or parts.
2. A thin, broken line shall be used to represent the boundaries of each subassembly.
3. Arrows adjacent to the parts shall indicate direction of flow.
4. Each part shall be identified by the schematic part designation. The numbers shall be assigned in a logical sequence observing flow paths through the system.
5. All inlet and outlet ports shall be identified.

6. The methods of attachment for each part shall be designated by an appropriate label or symbol.
7. The symbol used to designate a part shall be in accordance with MIL-STD-17-1 when applicable.
8. A brief description of the fluid system operation shall be provided.
9. Maximum operating pressure of the system and maximum pressure drop through the system (when operating at maximum pressure) shall be specified.
10. Table for pressure rating and connection of fluid system parts. Supplementary information on parts found in the fluid (piping) system schematic shall be contained in tabular form. One column shall contain the schematic part designation for each fluid system part; for example, valve V-1 and other similar designations. The other columns shall contain the following information:

    (a) Item number.
    (b) Description.
    (c) Type (size).
    (d) Pressure ratings (including operating, proof, and burst).
    (e) Method of attachment, including, as applicable, brazing or welding procedures, bonding agent, and seal (gasket, o-ring, and so forth).
    (f) End connections, fittings and adapters.
    (g) Relief valve ratings (include cracking and set pressure).

B. Complete electrical system schematic. A single schematic shall represent clearly the operation and the function of the electrical circuitry within the instrumentation. The schematic shall contain all parts (including components, connectors, alarms, and so forth) which make up the electrical system. The following features shall be incorporated into the schematic:

1. In preparation of the schematic, emphasis shall be placed on simplicity and ease of understanding of circuit operation. Physical placement of components and connecting wiring may be ignored in the interest of simplicity and clarity of this diagram.
2. A thin, broken line shall be used to represent the boundaries of each unit or subassembly. Terminals, to which external connections are made, shall be shown within these boundaries, with the numbers, markings, type of signal, power and ground, as appropriate.
3. Each part (such as resistors, capacitors, relays, and so forth) shall be given a unique reference designation consisting of a letter denoting the type of part (as required by ANSI/IEEE 200) and a number assigned consecutively. The numbers shall be assigned in a logical sequence of electrical current or signal flow through the circuit.

4. In addition to where the reference designation, parts not conforming to a military specification, where permitted, shall have the following information noted adjacent to the part. Where numerical values are given, a code shall be noted to designate the units used:

   (a) Resistors. Resistance, power rating, and tolerances. If variable, an arrow to indicate clockwise rotation of the control shaft.
   (b) Capacitors. Capacitance, voltage rating and tolerance.
   (c) Reactors. Inductance and voltage rating.
   (d) Semi-conductors. Type number (JEDDC number is adequate).
   (e) Integrated circuits. Operational symbol diagram of input-output relationship, terminal numbering corresponding to a representative schematic and type number.

5. Supply voltages, phases, and frequencies and transformer terminal voltage shall be indicated and labeled as to purpose.
6. Table for troubleshooting of electrical system. The content table shall include each test point, as identified on the electrical system schematic, with voltage, waveform or other electrical parameter that should be measured at each test point.

30.8 Selection and installation considerations.

A. Performance data.

   1. Accuracy (in percent of span).
   2. Shock and vibration classification.
   3. Degree of water tightness of the enclosure.
   4. Electromagnetic interference and pulse susceptibility.

B. Dimensional outline of the instrumentation showing overall and principle dimensions in sufficient detail to establish space requirements in all directions necessary for installation, servicing, exclusive of space required for operator observation of the indication.
C. Special considerations which may affect selection or installation.

   1. Ambient temperature range.
   2. Calibration points and adjustments.
   3. Orientation.
   4. Location of instrumentation relative to vibrating equipment.
   5. Protection of the instrumentation from pulsations and spikes in the parameter being measured.
   6. Selection of the instrumentation range relative to the operating range of the system.

7. Application for each type connection.
8. Cleaning procedure or reference to the cleaning procedure used.
9. Selection of the instrumentation for compatibility (materials, temperature, pressure, and so forth) with the ambient environment and with the parameter being measured.

30.9 Drawing format.

A. Unless otherwise approved by the authorized government activity, a maximum of three sheets shall be allotted for single functioned system instrumentation and a maximum of ten sheets for instrumentation containing a multiple functioned system. A single functioned system is one that performs only one operation such as: expands/contracts a pressure elastic element, steps up/steps down the voltage, conditions one electrical signal, or winds/unwinds a bimetallic element. A multiple functioned system is one that contains two or more single functioned systems.

B. Each sheet shall be zoned.

C. Title block shall be included on each drawing sheet and shall include the following information:

1. Title, drawing number, and revision letter. Each sheet shall contain the same title, drawing number and revision letter.

(a) Title. The title shall consist of the name by which the instrumentation is known.

(b) Drawing number. The drawing number shall consist of alphanumeric characters which may be separated by dashes or slashes. The total number of characters in the drawing number (including dashes and/or slashes) shall not exceed 15. Blank spaces are not permitted within the drawing number.

(c) Revision letter. The revision letter shall denote the latest approved version of the drawing. The revision letter of conformance verification drawing shall not be changed until all the changes under that revision have been accepted in writing by the authorized government activity (NAVSEA). No changes made to the conformance verification drawing shall be considered a revision until after the initial version of the conformance verification drawing has been accepted in writing by the authorized government activity. After initial submittal of the conformance verification drawing, no changes shall be made during the initial drawing review process unless the change is either requested by the authorized government activity or the change is documented in written correspondence by the contractor.

2. Sheet _____ of _____.
3. Tolerance on dimensions for fractions, decimals, and angles. Units of the dimensions specified on the conformance verification drawing.
4. Contractor acceptance block (appropriate signatures and dates.)
5. Federal supply code for manufacturer (FSCM).
6. Scale
7. Reference drawings.
8. Manufacturers name and address.
9. Drawing size.

D. Revision block. The revision block shall be included on each sheet of the conformance verification drawing and shall contain the following information in tabular form:

1. Revision letter.
2. Description of revision.
3. Acceptance letter serial number and originator identification.
4. Acceptance date.

E. Form. Sheet size and format not specified herein shall be in accordance with ANSI Y14.1.

F. Classification designations. No government security classification designation such as confidential or secret shall appear on the conformance verification drawing unless a particular classification is specified by the government.

40. CONFORMANCE VERIFICATION DRAWING ACCEPTANCE

40.1 Acceptance. Acceptance shall be granted by the authorized government activity only after the conformance verification drawing is found to meet all the requirements specified in 20. through 40.1.

50. Acquisition document instructions. The acquisition document should contain provisions that address submission, review, extension, disapproval, default, acceptance, and waiver of conformance verification drawings in addition to the effects on the delivery schedule due to delays in conformance verification drawing acceptance. NAVSEA shall be designated as the activity that accepts or disapproves the conformance verification drawing.